



I hereby certify that on December 19, 2001, which is the date I am signing this certificate, I am depositing this correspondence in the United States Postal Service, as first class mail, in an envelope addressed to the Assistant Commissioner of Patents, Washington, D.C. 20231.

Florence Thys-Doucet

Applicant: Liu et al.  
Serial No.: 09/558,453  
Filed: April 25, 2000  
Title: Spindle Motor With an Aerodynamic and Hydrodynamic Bearing Assembly  
Examiner: T. Lam  
Group Art Unit: 2834

#8/B (RE).  
Hawkins

1/29/02

## PATENT

### IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Assistant Commissioner for Patents  
Washington, D.C. 20231

### AMENDMENT AFTER FINAL

Sir:

In response to the Final Office Action of September 19, 2001 please amend the above-identified application as follows:

#### In the Claims

Please amend the claims as follows, a marked up set of the claims is appended hereto to show changes.

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2. (Amended) A spindle motor including a stator component and a rotor component, said components including a shaft and a hub, said shaft and hub being provided for relative rotation and said hub for supporting one or more discs, said hub including a hub sleeve including a cylindrical portion surrounding said shaft, said motor comprising a bearing assembly between the components, formed of a journal bearing and a thrust bearing, wherein the journal bearing is an aerodynamic bearing provided between said shaft and said cylindrical portion of said hub sleeve and the thrust bearing is adapted to function in a bi-directional manner and includes an annular member projecting radially from one of the shaft and sleeve into an associated recess

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formed in the other of the shaft and sleeve, wherein the annular member has two opposed bearing faces arranged adjacent corresponding bearing surfaces of said recess portion, and a hydrodynamic thrust bearing is formed between the respective bearing faces and surfaces, both a hydrodynamic thrust bearing and an aerodynamic journal bearing thereby being provided between said shaft and said hub sleeve of said components.

3. (Amended) A spindle motor as claimed in claim 2, wherein the journal bearing is formed between said shaft and said hub sleeve and the shaft is provided with a passage extending therethrough for providing air flow through the motor to the aerodynamic bearing, so as to allow air to be entrained into the journal bearing during operation.

4. (Amended) A spindle motor as claimed in claim 3, wherein the bearing surfaces diverge from the bearing faces adjacent said shaft so that liquid between the annular member and said recess portion of said hub sleeve is retained therebetween by surface tension seals.

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6. (Amended) A spindle motor as claimed in claim 5, wherein the shaft is fixed relative to the stator and the hub sleeve forms part of the rotor.

#### REMARKS

It is requested that the within amendment be entered in response to the Final Rejection of September 19, 2001 to place the within claims in better condition for allowance, appeal or continuation.

In applicant, both a liquid thrust bearing 52 and an aerodynamic journal bearing 54 are provided between shaft 22 of stator 16 and rotating sleeve 34 of rotor 18 in the exemplary embodiment. In such embodiment, shaft 22 is stationary while sleeve 34 of the hub of rotor 18 is rotating. Specifically the journal bearing provided is an aerodynamic bearing provided between the shaft and the cylindrical portion of the hub sleeve. The thrust bearing is also provided in a

recess portion formed between the shaft and hub sleeve as recited in the claim. The construction of the claim thus provides for there being both a hydrodynamic thrust bearing and an aerodynamic journal bearing provided between the shaft and the hub sleeve of the stator and rotor components. It is submitted that this construction and mode of operation is not found in the primary reference.

In the Lee patent, the journal bearing and the thrust bearing are provided separately of one another between different portions of the motor. As seen in Fig. 3 of the Lee patent, the thrust bearing is provided by a stationary thrust plate 142a on the stationary shaft 122a. A containment plate 154a and other portions of the main hub 128a to which plate 154a is attached form the rest of the liquid hydrodynamic bearing of Lee. Contrary to the construction and mode of operation of applicant, Lee provides a radial load or aerodynamic bearing between the hub sleeve 162a and a surrounding stationary sleeve 166a which in turn is mounted to a mounting plate which in turn is connected to the shaft 122a. Lee does not provide the hydrodynamic thrust bearing and aerodynamic journal bearing between the shaft and hub as in applicant but rather provides an additional component associated with the shaft, i.e., sleeve 166a which requires assembly and positioning within the motor during manufacturing operations.

Lee's spindle has two separate bearings, while the claimed invention has an integrated bearing system. The claimed invention (i.e. the integrated bearing system) is particularly advantageous for high-speed operation which is demanded by the market. The typical rotating speed of a hard disk drive spindle is 7200 rpm (rev. per minute) and now spindles with 12000 rpm are in the market and some high-speed spindles operating at 20000 rpm and above are demonstrated in lab environment.

In contrast the two separate bearing system of Lee suffers mainly

- a) the effect of the centrifugal force;
- b) the inherent problem with the misalignment of the two rotating axis of the two bearing systems and other manufacturing variability.

The construction of Lee is believed to possibly result in poor performance if the bearing are not aligned properly or an increased manufacturing cost to provide the required alignment.

It is submitted that the spindle motor construction in accordance with the present invention is easier to fabricate. The hub sleeve portions 34, 36 and 38 of applicant provide for the thrust bearing and journal bearing forming a bearing cartridge or a bearing subsystem with shaft 22 which can be fabricated independently and is separable from the rest of the spindle. In the primary reference, independent fabrication of the bearing subsystem is not possible as it is not separable from the whole spindle as in applicant. In manufacturing processes, spindle motors according to the present invention have the advantage of the novel provision of a datum surface therefore, the relative positional accuracy of the components in the motor thus being relatively easier to achieve. In the primary reference, the provision of multiple datum surfaces to be located reduce the ease of manufacture and render the design less practical than in applicant.

It is submitted that applicant's dependent claims 3 through 7 add features, which in the environment of the novel construction of mode of operation of claim 2, add patentable features to the overall motor construction. Reconsideration and allowance of all claims presented is respectfully requested.

The Commissioner is hereby authorized to charge any additional filing fees under 37 C.F.R. § 1.16, or application processing fees under 37 C.F.R. § 1.17, which may be required now or during the pendency of this application, or credit any overpayment to Account No. 16-2230.

Respectfully submitted,



Dated: December 19, 2001

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